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The present research is a continuation of an AFOSR-sponsored program that has supported our research on CMR essentially since the discovery of the phenomenon. Over the past six years, the research program has revealed several important findings related to CMR. 1) The phenomenon is based primarily upon an across-frequency analysis of amplitude envelope. 2) All portions of the envelope do not appear to contribute equally to CMR: envelope dips carry the critical information; 3) CMR increases with the number of comodulated noise bands present, with diminishing returns after three bands are present; 4) The presence of non-comodulated bands within a set of comodulated bands can substantially decrease CMR; 5) When auditory grouping principles are applied to segregate the noncomodulated bands from the comodulated bands, CMR can be restored to a singnificant extent; 6) CMR occurs for FM, but a much smaller magnitude than for AM. 7) Part of the MLD appears to be based upon a process that is essentially identical to CMR.

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INTRODUCTION

The present research is a continuation of an AFOSR-sponsored program that has supported our research on CMR essentially since the discovery of the phenomenon. Over the past six years, the research program has revealed several important findings related to CMR. 1) The phenomenon is based primarily upon an across-frequency analysis of amplitude envelope. 2) All portions of the envelope do not appear to contribute equally to CMR: envelope dips carry the critical information; 3) CMR increases with the number of comodulated noise bands present, with diminishing returns after three bands are present; 4) The presence of non-comodulated bands within a set of comodulated bands can substantially decrease CMR; 5) When auditory grouping principles are applied to segregate the noncomodulated bands from the comodulated bands, CMR can be restored to a significant extent; 6) CMR occurs for FM, but at much smaller magnitude than for AM. 7) Part of the MLD appears to be based upon a process that is essentially identical to CMR.

Focus of work over previous 8 months

1. CMR and Auditory Grouping

The most important function of the auditory system is to segregate and monitor multiple acoustic sources in the environment. Unfortunately, it has proven difficult to study the auditory abilities contributing to this function in ways that might be considered to be objective. We believe that CMR experiments hold substantial promise in shedding light on this function in relatively objective ways. Therefore, one of our main goals and interests is to study auditory grouping/segregation, using CMR as one of the primary tools. Over the past 10 months we have adopted a multi-signal paradigm to relate CMR to auditory grouping. A previous study had shown that CMR actually *decreased* as the number of signal components went up (in noncomodulated noise, performance improves with increasing number of signal components, proportional to the square root of the number of components). Consider, for example, a noise background composed of three comodulated noise bands; detection threshold is lower when the signal is one component presented at the center frequency of one noise band than when the signal has three components, each presented at the center frequency of one of the three noise bands. We are interested in the idea that auditory grouping may contribute strongly to this phenomenon. The basic idea is that, in a CMR paradigm, *when the target shares characteristics that are in common with the background, sensitivity will suffer.* Thus when the target is only a single component, it differs in frequency composition from the three-component background. This difference contributes to overall detectability. When the target frequency composition is essentially identical to that of the masker, detection suffers. The principle is that the closer the signal characteristics are to the characteristics of the masker, the less likely it is that the hypothesis will be adopted by the auditory system that the signal actually represents something that is different from the masker alone (making it more likely that a signal trial will be interpreted as a masker alone trial). Our first step was to replicate the basic finding for the three band case, using comodulated bands centered on 1600, 2000, and 2400 Hz. This replication was successful, showing better performance for a three-component tone than for a one-component tone for the noncomodulated case, but worse performance for a three-component tone than for a one-component tone for the comodulated case. The next strategy was to give the masking background spectral characteristics that were different from the spectral characteristics of the three-component signal. The first step in doing this was to keep the signal components at 1600-2000-2400 Hz, but to give the masker additional comodulated components (at 800, 1200, 2800, and 3200 Hz. The preliminary data indicate that although the multicomponent signal still does not provide a better threshold than the single-signal case, the threshold is at least no worse. This lends some support for the grouping hypothesis. The next step was to derive a multicomponent signal and comodulated masker configuration such that the signal actually resulted in a different residue (virtual) pitch than the residue pitch of the background noise; here, preliminary data suggest that the multicomponent signal actually results in a lower threshold than the single component signal case. We believe that there is a very good chance that this paradigm will prove important in establishing the relation between CMR and auditory grouping, and in providing an objective way to study auditory grouping principles.

Within this same general framework we have also made progress in potentially explaining the fact that CMR is often greater when the masker is continuous than when the signal and masker are gated on and off together. Here, again, the principle may apply that delectability will suffer when the target and masker background share common characteristics; here, performance suffers when the target and masker have the same gating pattern. The auditory system may be more likely to reject the hypothesis that the signal is something different from the background when the target and background are gated on and off together. In this sense the signal in the gated CMR paradigm can be seen as providing the auditory system with conflicting cues: the across-frequency difference resulting from the signal is evidence that something has occurred at the signal frequency that is different from the masking background; but the fact that the signal came on and went off with the masker is evidence that the signal is simply part of the masker. Our work over the past 10 months has been aimed at varying the relative strengths of the two potentially conflicting cues (gating versus across-frequency difference). Preliminary data are again in agreement with the grouping hypothesis, in that gating effects can apparently be reduced (or even eliminated) by increasing the strength of the across-frequency difference cues. Together with the spectrally-based experiments (paragraph above) we are beginning to get a coherent account of CMR in terms of principles of auditory grouping. These experiments may strengthen the claim that CMR reflects processes that contribute to auditory grouping, and should improve our understanding of auditory grouping.

2. The relation between CMR and MDI

The other area that we have concentrated on in the last 10 months is the paradoxical relation between CMR and MDI. In CMR, a signal creates an across-frequency difference in a masker background, and this difference provides evidence for detection that is better than the evidence available from analysis of information at the signal frequency. In MDI, the signal/masker profile again potentially provides across-frequency difference information that is more informative than the information at the signal frequency; however, here the presence of the off-signal information actually hurts performance. This conflict has not been satisfactorily resolved, but it is important to do so to allow a coherent account of both phenomena. In the work underway, we are using a gap detection paradigm, where the listener must detect a gap in a narrowband noise at one frequency when narrowband noises (not containing gaps) are present at other frequencies. The initial results appear to be promising, in that by known manipulations we are able to create situations where the off-frequency information makes gap detection at the signal frequency considerably more difficult, whereas with other manipulations we are able to create situations where the off-frequency information makes gap detection at the signal frequency significantly better. We are in the process of establishing rules for outcome.